SECTION 6.1

CONSUMER PRODUCTS
NON-AEROSOL SOLVENTS

(Updated May 1989)

EMISSION INVENTORY SOURCE CATEGORY
Solvent Evaporation / Consumer Products

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTIONS
510-514-8000-0000 (83089) Nonaerosol Solvents

METHODS AND SOURCES

This category is used to inventory the total organic gas (TOG) emissions from solvents contained in non-aerosol consumer products including household products, personal products, and automotive products. These products may be used in residential, institutional, and commercial establishments. Some major non-aerosol consumer products include window cleaners, general purpose cleaners, spot removers, floor and furniture polishes, household adhesives and sealants, electric pre-shave, non-aerosol hair care products, after shave, stick and roll-on deodorants, nail care products, rubbing alcohol, mouthwash, lotions, radiator and windshield washer antifreezes, and automotive brake fluid.

The term solvent is used in this document to specify organic compounds that are contained in the ingredients of a consumer product and that give rise to organic gas emissions. The total organic gas emissions from the solvents contained in these non-aerosol consumer products are inventoried under CES 83089, while the total organic gas emissions from the propellants and solvents contained in aerosol consumer products are inventoried separately under CES 83196 and 83204, respectively.

Solvent emissions from aerosol consumer product pesticides are not included in this category, but are inventoried under CES 83238 and 83246; emissions from non-aerosol consumer product pesticides will be inventoried under CES 83253 when data are available to estimate emissions. For non-aerosol architectural coatings, consumer product uses could not be disaggregated from available data on all uses. Therefore, no emission estimates for non- aerosol consumer product architectural coatings are included here; rather, all non-aerosol architectural coatings are inventoried under 3 CES numbers for architectural coatings, CES 46755, 46763, and 46771.

Solvent emissions from non-aerosol consumer products are calculated based on various methodologies that rely on available data. Two studies provide emission estimates for many of the products. Under contract with the ARB, the Science Applications International Corporation (SAIC)[1] conducted a study to determine organic gas emissions in California. From estimated national sales and solvent composition of the products, SAIC derived emission estimates for 1980. ARB staff updated these emission estimates to 1987 by applying a multiplicative growth factor to the emission estimate or by applying the reported methodology to 1987 activity data. SAIC data or methodology was used to estimate emissions from the following products: nail care products, electric pre-shave, after shave, rubbing alcohol, window cleaners, spot removers (corrected to represent non-aerosol products only), ball point and porous tip pens, household adhesives and sealants, and general purpose cleaners. With the exception of spot removers, we have assumed that SAIC emission estimates from those products represent non-aerosol product usage.

Some categories of consumer products were studied by KVB [2] and emission estimates were made for 1972, based on national sales data. ARB staff updated these emission estimates to 1987 by applying a multiplicative growth factor of 1.329, representing the change in California population from 1972 to 1987. KVB emission estimates were used for the following products: floor polish, shoe polish, furniture polish, metal polish, hair tonic, shampoo, hair rinse, mouthwash, creams, suntan oils, hand lotion, and cleaning lotion. We have assumed that KVB emission estimates represent non-aerosol product usage.

ARB staff assumed that the organic compounds considered by the SAIC and KVB in their emission estimates represent the compounds responsible for total organic gas emissions. These compounds responsible for TOG emissions are referred to as solvents in this document, independent of their function as dissolving agents.

In conjunction with the ARB Stationary Source Division, [3] emission estimates were made for non-aerosol underarm products including stick and roll-on antiperspirants and roll-on deodorants. The emission estimates rely on available data which reflect 1985 rather than 1987 usage data.

Table III contains detailed organic gas usage estimates calculated for non-aerosol consumer products. With the exception of radiator antifreeze, it was assumed that all of the solvent used in these non-aerosol products is emitted eventually into the atmosphere. The notes for Table III further explain the methodologies used for estimating usage and emissions.

Specific procedures for estimating organic gas emissions from non-aerosol consumer products follow.

Non-aerosol antiperspirants and deodorants. Emission estimates for non-aerosol underarm products including sticks and roll-ons were provided by the Stationary Source Division, ARB.[3] The data obtained from SSD staff reflect 1985 emission estimates. The key assumptions made by the SSD staff include the following.

SSD staff calculated the 1985 market share for each product type based on Chemical Specialties Manufacturers Association (CSMA) data (cited in ARB, [3] page 10). The market shares are as follows: aerosols: 25 percent, sticks: 41 percent, and roll-ons: 29 percent. Because other forms of underarm products (creams, pads, pump sprays, and plastic squeeze bottles) made up collectively 5 percent of the market share in 1985, SSD staff made no emission estimates for these products.

Nationwide production data for aerosol underarm products were available for 1985; these data were apportioned to California on the basis of population. California population was approximately 11 percent of the U.S. total in 1985 (ARB, [3] page 52). These data and the market share data discussed above are used to derive production data for sticks and roll-ons.

Also, according to the Chemical Specialties Manufacturers Association (cited in ARB, [3] pages 15 and 22), the market breakdown of stick underarm products is 70 percent antiperspirants and 30 percent deodorants, and all roll-on underarm products are antiperspirants.

SSD staff cited the following ranges for the photochemically reactive organic compound content of these products: stick antiperspirants: 80 percent, stick deodorants: 78-89 percent, and roll-on antiperspirants: 7-82 percent (ARB, [3] page C.18).

Based on these data, SSD staff estimated 1985 emissions to be 1,789 tons from sticks and 528 tons from roll-ons.

A review of population data from the California Department of Finance, Population Research Unit,[4] shows that the state's population grew approximately 3.8 percent from 1985 to 1987. This value is applied to 1985 emissions to derive the 1987 emission estimates of 1,857 tons per year from sticks and 548 tons per year from roll-ons.

Hair spray pumps. Emission estimates for 1983 were provided by the Stationary Source Division, ARB.[5] Assumptions include an average unit weight of 6 ounces, 91 percent volatile organic compound (VOC) content, 1980 data for market share of pump type products relative to aerosol hair sprays, and 1983 data from the Chemical Specialties Manufacturers Association[6] on number of aerosol units. Total organic gas emissions from non-aerosol hair sprays (pumps) were estimated to be 2,389 tons in 1983. ARB staff updated this estimate to 1987 based on population growth. According to the California Department of Finance, Population Research Unit,[4] the state's population grew by 8.1 percent from 1983 to 1987. The value of 1.081 is thus applied to 1983 emissions to derive the 1987 emission estimate of 2,582 tons per year.

PRODUCTS CONTAINED IN THE SAIC REPORT

SAIC[1] reported product use and emissions for many personal care and household products for California for 1980. For some products, such as ball point and porous tip pens, the SAIC analysis may include some commercial as well as consumer uses of the product. ARB staff has assumed however, that the SAIC estimates can be used to reasonably represent consumer usage. ARB staff updated the SAIC 1980 emission estimates to 1987 using data on population or number of households as appropriate. A discussion of each of the products follows.

Nail care. To estimate emissions for nail coatings and nail polish remover, ARB staff followed a basic methodology presented by SAIC,[1] which uses market research surveys and a survey of salon customers. ARB staff modified the SAIC methodology to incorporate 1987 data for the number of adult females in California, and recalculated salon survey data accordingly. ARB staff also modified and assumed product densities for nail coatings and for nail polish removers to be 0.88 gm/cm^3 and 0.791 gm/cm^3, respectively. The key aspects of the calculations follow.

According to a 1980 survey performed by the Simmons Market Research Bureau (cited by SAIC[1]), about 63.7 percent of adult females (over 19 years old) either apply nail polish themselves at home or have their nails done at salons. Interpolating 1985 and 1990 data from the California Department of Finance, Population Research Unit, [4] ARB staff estimates that there were 9.89 million adult females in California in 1987. Assuming the same percentage applies to 1987, it is estimated that 6.3 million persons used nail polish. Product use patterns are different for homes and salons; it was therefore necessary to estimate how many women fall into each location-of-use category. A 1982 survey conducted by Modern Salon (cited by SAIC [1]) of women who were having their hair done at a salon found that 81 percent of the women interviewed did their own nails at home only, 9 percent had them done at salons only, and 10 percent did them both at home and at salons. Assuming that these percentages apply to adult females in general (not just to those who have their hair done at salons), the estimated number of California women in each location-of-use category is:

Home only: 6.3 million x 81% = 5.10 million
Home or Salon: 6.3 million x 10% = 0.63 million
Salon only: 6.3 million x 9% = 0.57 million

In addition, the Simmons Market Research Bureau study determined that one quarter of the California females in the 15-19 year old population do their own nails at home. Again interpolating Population Research Unit [4] data and assuming the same fraction applies to 1987, ARB staff estimates that 0.235 million 15-19 year old females do their own nails at home.

The number of bottles consumed by each type of user was determined by multiplying the number of users by the frequency of nail polish application and by the fraction of bottle used per application. (SAIC [1] also included a breakdown by coating type. Coating types refer to nail enamel, clear enamel, base coat, and top coat.) Frequency of nail care was determined by SAIC based on Simmons Market Research Bureau data, discussions with salons, and an

informal survey of SAIC staff (all cited in SAIC [1]). The service limit of a typical bottle was assumed to be 20 applications. Table I shows the results of our consumption estimates.

Based on an assumed nail polish density of 0.88 gm/cm ^{3} and an average bottle volume of 0.5 fluid ounces, the average weight of the bottle contents was determined to be 0.028 pounds per bottle. Using this information, as well as a solvent content value of 70.4 percent, derived from SAIC data, ARB staff estimated 1987 statewide use of solvent in nail polishes to be 248,990 pounds (124 tons) per year. All solvent used was assumed to be emitted eventually to the atmosphere.

Table I

Consumption Estimates for Nail Coatings
in California

Location of Use	1,000 Persons	Frequency (times/yr)	1,000 Applications	1,000 Bottles of Coating Consumed[(a)]
Home only (adults)	5,100	43.2	220,320	11,016.0
Home only (15-19)	235	18	4,230	211.5
Salons only	570	36	20,520	1,026.0
Home and Salons	630	12	7,560	378.0
TOTALS			252,630	12,631.5

(a) Assumes 20 applications per bottle of nail coating.

Finally, we considered the use of acetone in nail polish remover. The solvent content of this product is roughly 50 percent (Gosselin, 1976 cited by SAIC [1]). SAIC assumed that about 0.1 ounce of remover is used for every application of nail coating. Given the application frequency listed in Table I, ARB staff estimated that there were 2.53 x 10 ^{8} applications of nail coatings in California. Assuming a polish remover density of 0.791 gm/cm ^{3} (6.6 pounds per gallon), acetone use was estimated to be 651,310 pounds (326 tons) per year. All acetone used was assumed to be emitted eventually to the atmosphere.

Combining the total emissions for nail polishes and polish remover, ARB staff estimates TOG emissions to be 450 tons per year for 1987 in California.

Electric pre-shave. Electric pre-shave lotions use either ethanol or propylene glycol as a solvent.

Using market research information, SAIC [1] estimated that ethanol and propylene glycol use in electric pre-shave was 340,000 pounds (170 tons) and 1,100 pounds (0.55 tons), respectively, in 1980. ARB staff assumed that the growth in use of pre-shave could be approximated by the growth in the population of males 15 or more years old. According to the California Department of Finance, Population Research Unit, [4] the population of males 15 or more years old grew by 13.8 percent in California from 1980 to 1987. ARB staff multiplied the 1980 use values for propylene glycol and ethanol by 1.138 to get 1987 estimates. It is estimated that 386,900 pounds (193.5 tons) of ethanol and 1,252 pounds (0.63 tons) of propylene glycol were used for electric pre-shave lotions in 1987. Total organic gas emissions from electric pre-shave are therefore estimated to be 194.1 tons per year.

After shave. After shave products consist mainly of denatured alcohol (essentially ethanol) and propylene glycol. SAIC [1] estimated that ethanol and propylene glycol use are 2.7 million pounds (1,340 tons) and 30,500 pounds (15.3 tons), respectively, in 1980. The SAIC analysis included the following assumptions: three brands of after shave lotion, accounting for 44.5 percent of the market, contain propylene glycol; there is an average of 35 uses per ounce; 72.4 percent of the adult male population use after shave lotion; and the use frequency is 312 times per year.

According to the Population Research Unit, [4] the population of males 15 or more years old grew by 13.8 percent from 1980 to 1987. ARB staff updated the SAIC estimates by this amount. It is estimated that ethanol and propylene glycol use in after shave in 1987 are 3.05 million pounds (1,525 tons) and 34,710 pounds (17 tons), respectively. Total organic gas emissions from after shave products are therefore estimated to be 1,542 tons per year in 1987.

Rubbing alcohol. The main constituent of rubbing alcohol is isopropanol, which is normally present at 70 percent by volume. SAIC [1] reported that 2.3 million pounds (1,150 tons) were used in California in 1980, based on the following assumptions: national sales of rubbing alcohol in 1980 were $37,697,000; California sales were in proportion to the state's share of U.S. households, or 10.762 percent; the average price on drug store shelves was $1 per pint bottle in 1980; and the density of isopropanol is 6.554 pounds per gallon.

ARB staff assumed that the growth in use of rubbing alcohol could be approximated by the growth in the number of households in California. According to the Population Research Unit,[7] the number of households in California grew by 14.4 percent from 1980 to 1987. ARB staff therefore applied a factor of 1.144 to account for the increase of household usage of rubbing alcohol.

Total organic gas emissions from rubbing alcohol are therefore estimated to be 2.63 million pounds (1,315.6 tons) per year in 1987.

General purpose cleaners. SAIC [1] estimated usage data for three major brands of cleaners. These three brands which use ethylene glycol monobutyl ether (EGMBE) account for 33.8 percent of the market. The SAIC analysis was based on the following: a 1980 Simmons

Market Research Bureau study showed that 89.2 percent of U.S. households used general purpose cleaning products in 1980; SAIC estimated that the average household buys 3.4 packages of cleaning products; average weight fractions of solvent ranged from 0.035 to 0.06; SAIC estimated the average weight per package sold by examining supermarket stock or sales; and the total product density was estimated to be 8.345 pounds per gallon.

According to the Population Research Unit, [7] the number of households in California grew by 14.4 percent from 1980 to 1987. ARB staff multiplied the SAIC 1980 usage estimate of 700,000 pounds (350 tons) by 1.144. Total organic gas emissions from ethylene glycol monobutyl ether in general purpose cleaners are therefore estimated to be 800,000 pounds (400 tons) per year in 1987.

Window cleaners. Ethylene glycol monoethyl ether is the main solvent of interest in window cleaners. Isopropanol is used in only one brand. SAIC [1] calculated 1980 solvent use based on the following method and assumptions. SAIC did a small survey of window cleaners on supermarket store shelves to determine average weights per package for major brands. SAIC assumed that 84.4 percent of households used window cleaners and that the total product density was 8.345 pounds per gallon. SAIC obtained market share and solvent fraction data from the Simmons Market Research Bureau and Gosselin (cited by SAIC [1]). SAIC estimated that total use of ethylene glycol monoethyl ether and isopropanol in window cleaners was 1.2 million pounds (600 tons) and 420,000 pounds (210 tons) per year, respectively, for 1980.

According to the Population Research Unit, [7] the number of households in California grew by 14.4 percent from 1980 to 1987. ARB staff therefore multiplied SAIC's estimates by 1.144 to account for growth in household usage of window cleaners.

Total organic gas emissions from window cleaners are therefore estimated to be 1.85 million pounds (927 tons) per year in 1987.

Spot removers. Solvents in spot removers consist mainly of petroleum solvents, aromatic hydrocarbons and chlorinated hydrocarbons. SAIC [1] calculated 1980 solvent use from spot removers to be 421,900 pounds (211 tons) per year based on the following methodology. SAIC obtained composition data for major brands from product labels and Gosselin (cited in SAIC[1]). SAIC apportioned 1980 U.S. retail market data to California assuming 11.2 percent of national retail sales and surveyed store shelves to determine average unit prices.

The SAIC estimates include one aerosol spot remover product, namely K2R aerosol. Because emissions from aerosol consumer product spot removers are already accounted for in ARB's emission inventory under CES 83196 and 83204, the following calculation is made to remove the aerosol fraction from the total solvent used. (SAIC data are used for unit size, number of units sold, and solvent fraction.)

$$\text{Emissions from K2R Aerosol} = (6 \text{ oz/unit}) \times (1.2 \times 10^{6} \text{ units}) \times (1/16 \text{ lb/oz}) \times (56\% \text{ solvents}) \times (1 \text{ ton}/2{,}000 \text{ lbs})$$

= 126 tons in 1980

Remaining Non-aerosol Emissions = 211 tons - 126 tons
= 85 tons in 1980

According to the Population Research Unit, [7] the number of households in California grew by 14.4 percent from 1980 to 1987. ARB staff therefore multiplied SAIC's estimates by 1.144 to account for growth in household usage of non-aerosol spot removers.

For non-aerosol spot removers, ARB staff therefore estimates the total organic gas emissions to be 97 tons per year for 1987.

Ball point and porous tip pens. SAIC [1] estimated ethylene glycol usage for 1980 to be 37,000 pounds (18 tons) for fine line porous tip, other porous tip (except marking), rolling point and broad tip marking pens. According to the SAIC, inks used in ballpoint pens (including disposable pens and refills) must have high viscosity and therefore contain relatively high-molecular-weight glycols and glycol ethers. The SAIC did not include emission estimates for these ballpoint pen inks.

The SAIC analysis used national sales data, a California sales fraction of 11.2 percent, an SAIC shelf survey for unit prices, and information on the amount of ink in pens and the solvent composition of the ink, which SAIC obtained from the Federal Bureau of Alcohol, Tobacco and Firearms and from two major pen manufacturers. The SAIC estimates may include commercial as well as consumer use. SAIC had no information for fountain pens.

Because the number of households in California grew by 14.4 percent from 1980 to 1987 (Population Research Unit [7]), ARB staff updated the SAIC estimates by this amount.

ARB staff therefore estimates the total organic gas emissions for pens to be 42,330 pounds (21 tons) per year for 1987.

Household adhesives and sealants. The SAIC [1] analysis was based on the results of an adhesive sales survey undertaken by a trade association which were provided to SAIC with the condition that the source not be identified. The survey did not include all adhesives producers in the country and would therefore be expected to under predict total sales. According to the survey, 27.7 million pounds of solvent-based adhesives and 22.1 million pounds of solvent-based sealants were used by households in 1981. SAIC assumed that California use is proportional to its 10.1 percent of national population. From composition data SAIC estimated that households used 370,000 pounds (185 tons) of acetone, 12,000 pounds (6 tons) of butyl acetate, 63,000 pounds (31.5 tons) of ethyl acetate, 600,000 pounds (300 tons) of hexane and 380,000 pounds (190 tons) of toluene for a total solvent use of 1.425 million pounds (712.5 tons) of solvents in domestic adhesives in 1981.

ARB staff updated these values to 1987 using a growth factor of 1.126 based on the increase in

the number of households from 1981 to 1987 (Population Research Unit [7]). Total organic gas emissions from household adhesives in 1987 are therefore estimated to be 1.6 million pounds (802 tons) per year.

SAIC provided no explicit estimates for the solvent content and resultant emissions of sealants. ARB staff assumed the solvent content of sealants to be the same as for adhesives, and used the SAIC reported value for sealant usage relative to adhesive usage to estimate organic gas emissions from sealants. Thus, 1981 emissions from sealants are estimated to be 1.14 million pounds (1.425 million lbs x 22.1 million lbs sealants/27.7 million lbs adhesives). ARB staff updated the result by the 12.6 percent growth in California households between 1981 and 1987 (Population Research Unit [7]). Total organic gas emissions from sealants are therefore estimated to be 1.28 million pounds (640 tons) per year in 1987.

For household adhesives and sealants combined, then, total organic gas emissions are estimated to be 2.88 million pounds (1,442 tons) per year in 1987.

AUTOMOTIVE PRODUCTS CONTAINED IN THE SAIC REPORT

SAIC[1] reported product usage and emissions for several automotive products used in commercial and consumer applications. ARB staff updated the SAIC estimates to 1987 by developing a growth factor based on the increase in motor vehicle registration. A discussion of these automotive products follows.

Radiator antifreeze. Cooling system antifreeze products are based on ethylene glycol. The analysis by SAIC[1] relied on a survey of 11 ethylene glycol-based antifreeze manufacturers for the Chemical Specialties Manufacturers Association, from which national sales to civilian and government consumers in 1980 were found to be 184.3 million gallons.

SAIC assumed that California's antifreeze use is proportional to its fraction of vehicle registration, determined by SAIC [1] to be 9.7 percent. Because the major brands of antifreeze contain at least 95 percent ethylene glycol, SAIC therefore assumed the density of the solution to be 9.25 pounds per gallon. Using these data, SAIC estimated that 165 million pounds (83,000 tons) of ethylene glycol were used in California in 1980.

To update the SAIC estimates to 1987, ARB staff developed a growth factor based on the increase of California vehicle registration from 1980 to 1987. California registration at the end of 1980 was 15 million vehicles (cited in SAIC [1]). California's vehicle registration at the end of 1987 was 21.3 million vehicles.[8] The growth in California vehicle registration from 1980 to 1987 was therefore 42 percent.

Multiplying the SAIC 1980 estimate of ethylene glycol use by 1.42, ARB staff estimates that 117,860 tons of ethylene glycol were used in radiator antifreeze in 1987.

In contrast to most other products, it is unlikely that the entire quantity of antifreeze used is

emitted to the atmosphere, because of the properties of the solvent and the manner of disposal. No estimates are available to directly quantify the emissions from the disposal of spent antifreeze. An upper limit could be based on the amount used and the assumption that all the antifreeze is discarded. However, ethylene glycol has extremely low volatility and is biodegradable.[9] Ethylene glycol degrades completely within 3-20 days in freshwater or 2 days in soil, and it degrades to about 77 percent completion in saltwater in 20 days. [9] Antifreeze is expected to be biochemically degraded before chemical degradation becomes significant. Some of the species of bacteria that degrade the antifreeze are Pseudomonas, Acetobacter, Achromobacter, and Mycobacterium.[9] Following the assumption reported by SAIC, ARB staff assumes that 5 percent of the amount of antifreeze used is ultimately emitted into the air.

Total organic gas emissions from antifreeze used in California are therefore estimated to be 5,893 tons per year in 1987.

Windshield washer antifreeze. Windshield washer antifreeze is sold as a premix or as a concentrate. Methanol is the principal solvent in these products. SAIC [1] assumed typical volumetric percentages (and corresponding densities of methanol solutions) to be 35 percent (7.75 pounds per gallon) for premix and 69 percent (7.19 pounds per gallon) for concentrate.

SAIC obtained 1974 data for U.S. sales from a survey by Charles H. Kline and Company, Inc. SAIC reports that 14 million and 2 million gallons of premix and concentrate, respectively, were sold in 1974. SAIC then updated these values to 1980, based on the growth in U.S. vehicle registration from 1974 to 1980. According to the Motor Vehicle Manufacturers Association (cited in SAIC [1]), U.S. vehicle registration grew by 20.45 percent between 1974 and 1980.

SAIC then assumed that California's use is proportional to its fraction of vehicle registration. California vehicle registration at the end of 1980 was 15 million vehicles or 9.7 percent of the nation's total of 154.3 million vehicles. Using these data, SAIC estimated that the use in California of methanol in these products is 13 million pounds of premix and 1.7 million pounds of concentrate. To update the SAIC estimates to 1987, ARB staff applied the growth factor of 1.42, based on the increase in California vehicle registration from 1980 to 1987, to the SAIC 1980 estimates for premix and concentrate. Emissions from methanol use in windshield washer antifreeze were thus estimated to be 18.5 million pounds (9,250 tons) per year for premix and 2.4 million pounds (1,200 tons) per year for concentrate in California in 1987. Total organic gas emissions from windshield washer antifreeze are therefore estimated to be 10,450 tons per year in 1987.

Brake fluid. Brake fluid is about 85 percent ethylene glycol monoethyl ether (EGMEE) by weight (Gosselin, 1976 cited by SAIC [1]). Brake fluid is used in the original manufacture of the automobile and in replacing master cylinders. While SAIC considered both these uses, ARB staff assumed that the main source of emissions is from replacement of master cylinders and followed the SAIC methodology for estimating these emissions only.

SAIC[1] estimated 1980 EGMEE usage for master cylinder replacement, based on discussions with automobile repair shops. SAIC provided a table showing use of EGMEE broken down by frequency of repair of vehicles of various ages, based on 1980 data. ARB staff modified the SAIC analysis to represent 1987 as follows. According to information published by the California Department of Transportation,[8] California vehicle registration at the end of 1987 was 20.57 million vehicles (auto and commercial vehicles only). California vehicle age distribution for 1983, obtained from CDOT,[10] was assumed applicable to 1987. ARB staff assumed the same repair frequency for each vehicle age group. Finally, following SAIC, ARB staff assumed the brake fluid to have the same density as the solvent EGMEE. The results of the ARB staff calculations are summarized in Table II.

Because ethylene glycol monoethyl ether has a vapor pressure of 3.8 mm at 20 ^{0} C, we assume that 100 percent of the amount used is ultimately emitted to the air.

Total organic gas emissions from brake fluid in California are estimated to be 2.97 million pounds (1,485 tons) per year in 1987.

Table II

Estimation of Ethylene Glycol Monoethyl Ether (EGMEE)

Use in Master Cylinder Replacement

Age of Vehicle (years)	Vehicles Registered in California[(a)]		Vehicles Needing Master Cylinder Replacement[(b)]		Brake Fluid (gallons)[(c)]	EGMEE Use (pounds)[(d)]
	Pct.	# Vehicles	Pct.	# Vehicles		
4-5	15.9	3,271,212	0	0	0	0
6-7	15.6	3,209,491	5	160,475	40,120	264,290
8-9	10.4	2,139,661	10	213,966	53,490	352,360
10-11	11.9	2,448,266	15	367,240	91,810	604,800
12-13	8.9	1,831,056	20	366,211	91,550	603,090
>13	16.9	3,476,949	20	695,390	173,850	1,145,240
TOTALS					450,820	2,969,780

(a) The 1983 vehicle age distribution, obtained from the California Department of Transportation (Hoyt, 1984),[10] is assumed applicable to 1987. The percentages are applied to the total number of vehicles registered in California to derive the number of vehicles within each age group. There were 20,573,663 vehicles registered in 1987.[8]

(b) The percentages of vehicles within each age group requiring master cylinder replacement

were derived by SAIC [1] for 1980 and are assumed applicable to 1987.[8]

(c) According to SAIC,[1] 1 quart of brake fluid (or 0.25 gallons) is used per vehicle.

(d) Brake fluid is about 85 percent EGMEE by weight and the density of EGMEE is 7.75 pounds per gallon, according to SAIC.[1] EGMEE use is thus calculated:

Brake fluid (gal) x 0.85 x 7.75 lbs/gal = EGMEE (lbs)

Products Contained in the KVB Report. KVB [2] reported product use and missions for many household products for 1972, based on national sales data. California's portion of these emissions was determined by ARB staff on the basis of population. These emissions were then updated from 1972 to 1987 using a growth factor of 1.329 which represents the growth in California population between 1972 and 1987. [4] The products and the corresponding 1987 annual emission estimates are as follows: floor polish (2,336 tons); shoe polish (80.5 tons); shampoo (1,021 tons); hair tonics (16.7 tons); hair rinses (77.2 tons); mouthwash (1,118 tons); creams (1,490 tons); suntan oil (302 tons); hand lotion (684 tons); cleaning lotions (926 tons); furniture polish (1,422 tons); and metal polish (215 tons).

Summary of Solvent Usage and Countywide Emissions

As already indicated, Table III reports statewide estimates of solvent usage for each of the non-aerosol consumer products considered. With the exception of radiator antifreeze, the tons of solvent used are assumed to equal the tons of solvent emitted to the atmosphere (i.e. the TOG emission factor is assumed to be 2,000 pounds per ton). The total of the emissions for all the non-aerosol products (38,892 tons per year statewide) is inventoried under CES 83089.

The statewide process rate and emissions are apportioned to the counties based on relative population in 1987. The countywide process rates and total organic gas emissions for non-aerosol consumer products are reported in Table IV.

ASSUMPTIONS

1. Data from the studies conducted by Science Applications International Corporation and KVB, Inc. are reasonable bases for estimating emissions of most non-aerosol consumer products.

2. Emission estimates for previous years can be updated to 1987 by assuming that population growth or growth in number of households is directly proportional to product usage. Emission estimates for automotive products can be updated by assuming that growth in vehicle registration is directly proportional to an increase in automotive product usage.

3. Emission estimates can be disaggregated to counties based on population proportioning.

4. The number of units of product sold equals the number of units used, and all products produced for one year are sold in that year.

5. The entire quantity of organic solvent contained in the non-aerosol products used is emitted ultimately to the atmosphere, with the exception of radiator antifreeze.

COMMENTS AND RECOMMENDATIONS

Emissions from the use of non-aerosol consumer products contribute significantly to the total organic gas inventory. In general, the assumptions made to estimate usage and emissions for this category need to be improved. Some specific recommendations follow.

With the exception of radiator antifreeze, ARB staff assumed that all of the organic solvent contained in the product evaporates. Additional studies may be needed to determine the exact proportion of the total solvent content that is emitted for each type of product. For products that are used indoors, more study is needed to determine what proportion of the organic gases is ultimately emitted into the outdoor air.

For several product types, for which aerosol and non-aerosol forms exist, we have assumed that available emission estimates reflect primarily non-aerosol market shares. Surveys should be conducted to determine non-aerosol market shares. Actual market share data are needed to accurately determine weighted average compositions. Surveys should also be conducted to separate institutional and commercial uses from home usage for several product categories.

Because many of the organic compounds in consumer products may be potential toxic air contaminants, further study is recommended to improve product composition data for this source category.

Data on solvent usage for additional products not considered here should be obtained to make the inventory more complete.

CHANGES IN METHODOLOGY

There are no changes in methodology.

DIFFERENCES BETWEEN 1987 AND 1983 EMISSION ESTIMATES AND METHODOLOGIES

Emissions for 1987 are higher than those for 1983 due to increases in population, number of households, and in vehicle registration.

TEMPORAL ACTIVITY

Annual activity is nearly uniform. The daily activity occurs primarily during daylight hours.

REFERENCES

1. Science Applications International Corporation, Development and Improvement of Organic Compound Emission Inventories for California, Final Report, (1985).

2. KVB, Inc., Control of Hydrocarbon Emissions From Stationary Sources in the California South Coast Air Basin, Final Report, (1978).

3. California Air Resources Board, Stationary Source Division, Draft Technical Support Document for Reducing Organic Compound Emissions from Antiperspirants and Deodorants, (December 1988).

4. California Department of Finance, Population Research Unit, "Projected Total Population for California by Race/Ethnicity, July 1, 1970 to July 1, 2020", Report 88 P-4, (February 1988).

5. California Air Resources Board, Stationary Source Division, Staff Calculations, (1986).

6. Chemical Specialties Manufacturers Association, Inc., Pressurized Products Survey United Stated 1983, (1984).

7. California Department of Finance, Population Research Unit, "Population and Housing Estimates for California Cities and Counties", Report E-5, (1980, 1981, and 1987).

8. California Department of Transportation, Travel and Related Factors in California, Annual Summary, 1987, (1988).

9. Miller, L. M., Investigation of Selected Potential Environmental Contaminants: Ethylene Glycol, Propylene Glycols, Butylene Glycols, EPA 560/11-79/006, PB 80 109119, Report prepared by Frontier Research for EPA, (1979).

10. Hoyt, Beverly. California Department of Transportation, Sacramento, CA. Personal communication, (November 1984).

PREPARED BY

Andy Delao
May 1989

Table I
1987 Area Source Emissions
Activity: Domestic
Process: Solvent Use
Entrainment: Solvent -Evap
Dimn: Non Aerosol Prods Consumer Products
CES: 83089
Process Rate Unit: Tons of Solvent Consumed

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	2	1.69	0.00	0.00	0.00	0.00
	INYO	25	25.31	0.00	0.00	0.00	0.00
	MONO	13	12.93	0.00	0.00	0.00	0.00
LC	LAKE	71	71.42	0.00	0.00	0.00	0.00
LT	EL DORADO	44	43.91	0.00	0.00	0.00	0.00
	PLACER	15	15.30	0.00	0.00	0.00	0.00
MC	AMADOR	36	35.71	0.00	0.00	0.00	0.00
	CALAVERAS	42	41.62	0.00	0.00	0.00	0.00
	EL DORADO	115	115.24	0.00	0.00	0.00	0.00
	MARIPOSA	20	19.68	0.00	0.00	0.00	0.00
	NEVADA	104	103.76	0.00	0.00	0.00	0.00
	PLACER	22	22.26	0.00	0.00	0.00	0.00
	PLUMAS	28	27.84	0.00	0.00	0.00	0.00
	SIERRA	5	4.78	0.00	0.00	0.00	0.00
	TUOLUMNE	63	62.99	0.00	0.00	0.00	0.00
NC	DEL NORTE	27	27.27	0.00	0.00	0.00	0.00
	HUMBOLDT	160	159.85	0.00	0.00	0.00	0.00
	MENDOCINO	105	105.44	0.00	0.00	0.00	0.00
	SONOMA	81	81.40	0.00	0.00	0.00	0.00
	TRINITY	19	19.12	0.00	0.00	0.00	0.00
NCC	MONTEREY	482	482.37	0.00	0.00	0.00	0.00
	SAN BENITO	47	46.68	0.00	0.00	0.00	0.00
	SANTA CRUZ	313	313.38	0.00	0.00	0.00	0.00
NEP	LASSEN	37	37.26	0.00	0.00	0.00	0.00
	MODOC	13	13.08	0.00	0.00	0.00	0.00
	SISKIYOU	60	60.31	0.00	0.00	0.00	0.00
SC	LOS ANGELES	11726	11725.60	0.00	0.00	0.00	0.00
	ORANGE	3117	3116.70	0.00	0.00	0.00	0.00
	RIVERSIDE	949	949.10	0.00	0.00	0.00	0.00
	SAN BERNARDINO	1362	1362.10	0.00	0.00	0.00	0.00
SCC	SAN LUIS OBISPO	284	283.86	0.00	0.00	0.00	0.00
	SANTA BARBARA	482	482.09	0.00	0.00	0.00	0.00
	VENTURA	883	883.06	0.00	0.00	0.00	0.00
SD	SAN DIEGO	3217	3217.20	0.00	0.00	0.00	0.00
SED	IMPERIAL	154	153.53	0.00	0.00	0.00	0.00
	KERN	98	97.67	0.00	0.00	0.00	0.00
	LOS ANGELES	203	203.00	0.00	0.00	0.00	0.00
	RIVERSIDE	338	337.80	0.00	0.00	0.00	0.00
	SAN BERNARDINO	328	327.80	0.00	0.00	0.00	0.00
SF	ALAMEDA	1722	1722.00	0.00	0.00	0.00	0.00
	CONTRA COSTA	1038	1038.00	0.00	0.00	0.00	0.00
	MARIN	321	320.83	0.00	0.00	0.00	0.00
	NAPA	149	148.92	0.00	0.00	0.00	0.00
	SAN FRANCISCO	1031	1031.00	0.00	0.00	0.00	0.00
	SAN MATEO	870	870.52	0.00	0.00	0.00	0.00
	SANTA CLARA	2006	2006.00	0.00	0.00	0.00	0.00
	SOLANO	310	309.88	0.00	0.00	0.00	0.00
	SONOMA	427	427.41	0.00	0.00	0.00	0.00
SJV	FRESNO	839	839.06	0.00	0.00	0.00	0.00
	KERN	612	612.04	0.00	0.00	0.00	0.00
	KINGS	124	123.58	0.00	0.00	0.00	0.00
	MADERA	113	112.61	0.00	0.00	0.00	0.00
	MERCED	234	233.66	0.00	0.00	0.00	0.00
	SAN JOAQUIN	625	624.65	0.00	0.00	0.00	0.00
	STANISLAUS	459	459.46	0.00	0.00	0.00	0.00
	TULARE	410	409.83	0.00	0.00	0.00	0.00
SV	BUTTE	238	238.02	0.00	0.00	0.00	0.00
	COLUSA	21	20.81	0.00	0.00	0.00	0.00
	GLENN	32	32.34	0.00	0.00	0.00	0.00
	PLACER	171	171.09	0.00	0.00	0.00	0.00
	SACRAMENTO	1332	1331.97	0.00	0.00	0.00	0.00
	SHASTA	190	190.40	0.00	0.00	0.00	0.00
	SOLANO	119	118.90	0.00	0.00	0.00	0.00
	SUTTER	85	84.78	0.00	0.00	0.00	0.00
	TEHAMA	65	64.53	0.00	0.00	0.00	0.00
	YOLO	181	181.36	0.00	0.00	0.00	0.00
	YUBA	78	78.31	0.00	0.00	0.00	0.00
TOTAL		38892	38892.07	0.00	0.00	0.00	0.00

Fraction of Reactive Organic Gases (FROG): 1.0000
(Reactive Organic Gases (ROG) Emissions = TOG X FROG)
Fraction of PM10 (FRPM10): .9600
(PM10 Emissions = PM X FRPM10)